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I

A NEW SPECIES OF CORAMBE FROM THE PACIFIC COAST OF NORTH AMERICA

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The Nudibranch genus *Corambe* forms a group concerning whose structure, life history, affinities and distribution, much remains yet to be learned. The general features of its organization seem to ally it to the phanerobranchiate Dorids, and in that group more especially to the Goniodorididæ. It has been placed by Bergh in his System (1892) in a separate family, the Corambidæ, and he indicates its probable close relationship to the little known, older genera *Hypobranchiæa* A. Adams, and *Doridella* Verrill, rather characteristically reducing them to synonymy with his own, later genus. While these two are unknown from an anatomical point of view, it is reasonably certain that they should be united with *Corambe* in the same family at least. In doing this we recognize the priority and correctness of the name proposed by P. Fischer (1883), and use it instead of the later one by Bergh. The family diagnosis given by Fischer has been slightly modified in the light of later information than was then available. Should future studies establish the generic identity of *Corambe* with either or both *Hypobranchiæa* and *Doridella,* the name given by Bergh would, of course, be cancelled in favor of the earlier one.

Family HYPOBRANCHIÆIDÆ P. Fischer, 1883.

Fischer, P., 1883. Manuel de Conchyliologie, Fasc. VI, p. 530.

Body, notæum, and rhinophores doridiform, branchiæ posterior, below the notæum margin and above the foot; anus median, posterior, between notæum and foot; reproductive openings anterior on right side; radula narrow, multiserial.

Genus 1. **Hypobranchiæa** A. Adams, 1847.

Adams, A., 1847. Proc. Zool. Soc. London, pp. 23-24.

Type: *Hypobranchiæa fusca* A. Adams.

Yellow Sea.

Genus 2. **Doridella** Verrill, 1870.

Verrill, A. E., 1870. Amer. Journal Science and Arts, I, p. 408.

Type: *Doridella obscura* Verrill.

Vineyard Sound; Long Island Sound.

Genus 3. **Corambe** Bergh, 1871.

Bergh, R., 1871. Verh. k. k. zool.-bot. Ges. Wien, XXI, pp. 1293-1294.

Type: *Corambe sargassicola* Bergh.

Sargasso Sea.

Genus 4. **Corambella** Balch, 1899.

Balch, F. E., 1899. Proc. Bost. Soc. Nat. Hist., XXIX, p. 151.

Type: *Corambella depressa* Balch.

Cold Spring Harbor, Long Island.

The present paper deals with the third of this list of genera, being a description with anatomical details of a new species of *Corambe* from the Pacific Coast of North America, for which the name *Corambe pacifica* is here proposed. Our grateful acknowledgments are due to Professor Walter K. Fisher, Director of the Hopkins Marine Station, Pacific Grove, California, for the free use of the facilities afforded by that laboratory during the prosecution of the greater portion of this study. We are also greatly indebted to Mrs. Olive H. MacFarland for her generous cooperation in the preparation of the figures which illustrate this account.

Corambe Bergh, 1871

Corambe Bergh, R., 1869. Bidrag til en Monographi af Phyllidierne. Naturh. Tidsskrift, 3 R, 5 B, p. 359; footnote.

Corambe Bergh, 1871. Beiträge zur Kenntnis der Mollusken des Sargassomeeres. Verh. d. k. k. zool.-bot. Gesellschaft Wien, Bd. XXI, pp. 1293-1297, Taf. XI, Fig. 21-27, Taf. XII, Fig. 1-11.

Corambe Kerbert, C., 1886. Over het Geslacht Corambe Bergh. Tijdschrift der Nederlandsche Dierkundige Vereeniging, 2 Sér., D. 1, Afl. 2, pp. 5-6. (Abstract in Bull. Sci. du Nord, 2 Sér., 9, 1886, pp. 136-138.)

Corambe Fischer, P., 1888. Note sur la présence du genre Corambe Bergh, dans le bassin d'Arcachon (Gironde). Bull. Soc. Zool. France, T. 13, No. 9, pp. 215-216.

Corambe Fischer, H., 1889. Note préliminaire sur la Corambe testudinaria. Bull. Soc. Zool. France. T. 14, No. 10, pp. 379-381.

Corambe Fischer, H., 1891. Sur l'anatomie du Corambe testudinaria. C. R. Ac. Sci. Paris, CXII, pp. 304-307.

Corambe Fischer, H., 1891. Recherches anatomiques sur un Mollusque appartenant au Genre Corambe. Bull. Sci. de la France et de la Belgique. T. XXIII (Sér. IV, Vol. II), pp. 358-398, Pl. IX-XIII.

Corambe Fischer, H., 1896. Note sur la distribution du Genre Corambe. Jour. Conchyl. Vol. XLIII, pp. 235-236.

Corambe Bergh, R., 1892. System der Nudibranchiaten Gasteropoden. Wiesbaden. Semper's Reisen im Archipel der Philippinen. Wissenschaftliche Resultate. Malacologische Untersuchungen, Bd. III, H. 18, pp. 166-168.

Corambe Vayssière, A., 1901. Étude comparée des Opistobranches des Côtes Françaises de l'Océan Atlantique et de la Manche avec ceux de nos Côtes Méditerranéennes. Bull. Sci. France et Belgique, T. XXXIV, p. 296.

Corambe Vayssière, A., 1913. Mollusques de France et des régions voisines. T. I., Paris, p. 363.

Body doridiform, oval, depressed; notæum somewhat convex, its margin wide, flattened, rounded in front, deeply notched in the median line behind, everywhere extending beyond the foot; rhinophores retractile within sheaths, the stalk bearing an inner pair of wing-like, lateral expansions, and surrounded by an outer sheath, free above, united to the stalk below, and deeply cleft or entirely free behind; foot emarginate in front, rounded behind, smaller than the notæum, which completely conceals it.

Branchiæ posterior, of a few separate, pinnate plumes symmetrically arranged on either side of the median line between the notæum and the foot; anus median, posterior, between the two groups of branchial plumes; tentacles short, nearly concealed by the notæum.

Pharyngeal bulb armed with two lateral thickenings at the buccal aperture; radula narrow, its rhachis naked, the innermost, lateral tooth large, bearing a denticulate hook, the outer laterals few, small, with a simple hook; buccal ingluvies connate with the pharyngeal bulb. Glans penis unarmed.

The genus *Corambe* is first mentioned by Bergh in 1869 in a brief footnote in a paper upon the Phyllidiidæ. The description, "a dorid-like mollusk with strong mandibles, with numerous (24) rows of teeth, with four laterals upon either side of a median series," can scarcely be taken as an adequate diagnosis of the genus, since there are neither mandibles nor median teeth present, nor could the form be identified by this statement alone. In 1871, however, the same author published a more extended diagnosis, based upon a study of a single specimen of the genotype, *Corambe sargassicola* Bergh, taken upon drifting seaweed in the Central Atlantic in 42° 50′ N. Lat., and 46° 20′ W. Long. The description is in many details quite inaccurate and incomplete, probably owing to the lack of material. A second species, *Corambe batava,* from the Zuider-Zee, was described by Kerbert in 1886 in a very fragmentary manner. In 1889 H. Fischer described a third species, *Corambe testudinaria* from the Bay of Arcachon, and in 1891 published an excellent anatomical account, which forms the actual basis of our knowledge of the genus. In the opinion of Vayssière (1913), these three species are identical, forming the single species *Corambe sargassicola* Bergh, which is not at all unlikely, though the accurate information respecting the species described by Bergh and by Kerbert, necessary to certainty in this regard, is lacking.

The new species of *Corambe* discussed in the present paper, differs markedly from the ones previously described. It has been taken by the authors in two widely separated localities, Monterey Bay, California, and at Nanaimo, British Columbia. In each instance the habitat is the same: *Membranipora* colonies upon the large kelps and *Zostera*, from which surroundings the minute animal is scarcely distinguishable. Its resemblance to a young colony of the bryozoan of similar size is even more perfect.

The species of the genus at present may be listed as follows:

1. *Corambe sargassicola* Bergh, 1871.
2. *C. batava* Kerbert, 1886.
3. *C. testudinaria* Fischer, 1889.
4. *C. pacifica* MacFarland & O'Donoghue, new species,

in which summary the first three are assumed to be valid and distinct species, in the absence of positive knowledge to the contrary.

Corambe pacifica MacFarland & O'Donoghue, new species.

Animal (Pl. 1, fig. 1) elliptical, flattened, disk-like, slightly arched in the central region of the body, the notæum everywhere extending beyond the foot, its margin wide and thin, with a deep, median, circular notch behind, elsewhere entire.

Foot rounded equally in front and behind, its anterior margin, beneath the head, with a deep, median notch revealing the mouth in the angle.

Head small, covered entirely by the notæum, its angles prolonged into short, blunt tentacles, directed outward and forward, their tips showing beyond the notæum margin, when the animal is crawling freely.

Rhinophores retractile into low, entire, thin-margined sheaths, the blunt, tapering tip of the stalk projecting above an incomplete, inner envelope, to which it is attached in the anterior, median line below, above free, the sheath-like expansion sloping rapidly downward behind to the rear of the stalk, with which it merges. Within this envelope the stalk bears a lower, plate-like expansion on either side, revolute backward, and inserted behind, above the more external sheath; a low, keel-like ridge, or plate, on the median, posterior side of the stalk.

Anal opening posterior in the median line, immediately below the notch of the notæum margin; close to it at its right and slightly above is the single, renal opening, a minute pore. Reproductive openings three, close together, far forward on the right side, between the notæum and the foot.

Branchiæ a series of simple, pinnate plumes, ranging in number in mature individuals from six to 12 or 14 on each side, decreasing in size from behind forward, borne on either side of the anal opening, between the foot and the notæum, and limited to the posterior third of sides of body. A single, median plume is usually situated immediately above the anus. Lamellæ of longest plumes 10 to 20 in number, opposite in arrangement upon sides of horizontally flattened shaft; at the insertion of the branchiæ a series of large, simple, alveolar glands, mostly alternating with the bases of the plumes, and co-extensive with them.

Color of dorsum a pale, translucent gray ground, the central area marked out by the pale, yellow-orange liver showing through the integument. Surrounding this central area is a whitish zone, determined largely by the foot showing through from below. Outside this zone and equal to it in width is the nearly transparent notæum margin. This marginal zone is marked with irregular, continuous and discontinuous lines of clear baryta-yellow, arranged radially. Toward the center of the dorsum these lines become broken up into dots of color, and are more irregularly scattered. These radial lines with their cross connections resemble the walls of the zooecia of *Membranipora* to a very marked extent. Between the superficial, baryta-yellow markings are larger and smaller flecks, in general radial in arrangement, and lying deeper in the integument. These are largest and most numerous in the second zone, and become smaller and more rounded in the central area. The central and major portion of each fleck is terra cotta in color, and is usually edged with an incomplete line of black. Around the rhinophore bases they may form an almost continuous ring, but are usually clearly separate. Scattered small, black flecks may also occur in the median area. In darker specimens the terra cotta spots are larger and more numerous, especially in the median region, their borders deepening to a greenish color, where not black. Foot clear gray, with a narrow, white, marginal line. Rhinophores clear, translucent gray, the sheath either the same or with a few small spots of terra cotta, baryta-yellow, or black.

Radula formula 38-40 x (4-5 + 1 + 0 + 1 + 4-5). Median tooth wanting. First lateral large, compressed, consisting of a slightly curved hook rising from the anterior angle of a large, erect base, the hook bearing three to seven denticles upon its inner margin. Upper posterior angle of the base of the first lateral thickened and pointed, forming a second, minor hook directed backward. Inner face of the base with a low, recurved, wing-like lamina, arising behind and below the lowermost denticles, and curving downward to the insertion of the base. Outer, lateral teeth, usually four, decreasing in size progressively outward, each consisting of a broad, rounded base bearing a slightly curved, simple, pointed hook. Rows of teeth not exactly opposite each other in the lateral halves of the radula.

Pleural ganglia not fused with the cerebral ones, but united to them by short connectives.

Length in life up to 13 mm., width up to 10 mm.

Habitat: Upon brown kelps, mainly *Macrocystis pyrifera* (Turn.) Ag. and *Nereocystis luetkeana* P. & R., and upon *Zostera marina* L., bearing incrustations of *Membranipora villosa* Hincks colonies, upon which the mollusks feed. Monterey Bay, California. Nanaimo, British Columbia.

Holotype: No. 634, Mus. Calif. Acad. Sci., collected May 21, 1928, by F. M. MacFarland, in **Monterey Bay, Pacific Grove, California.** *Paratypes* are deposited in the U. S. National Museum, the British Museum, the Biological Station at Nanaimo, B. C., the Hopkins Marine Station, Stanford University, and in the authors' private collections.

The careful study of *Corambe testudinaria* by H. Fischer (1891) renders unnecessary a detailed account of the anatomy of this new species, save as regards certain features of pronounced difference found by us. Detailed dissections were made and supplemented by serial sections from material imbedded in paraffin and in celloidin and stained in various ways.

Habitat: The animals are seldom found separated from the *Membranipora* colonies, and then probably through accident. They have been seen actively feeding upon the colonies of *Membranipora villosa,* which seem to be their chief food.

One of us (O'Donoghue, 1926) has described in detail the ravages of *Corambe* upon the bryozoan colony. "When young, even less than one mm. long, this mollusk has been seen inside the zooecium, from which it has eaten all the living matter. A more common point of attack, and the only one by larger *Corambe,* is the growing edge of the colony which is either not protected by a chitinous covering, or else by one so thin that it affords no protection. This method of wounding produces a very characteristic indentation of the growing edge. If of short duration, it is surrounded by the growing zooecia, and all that is left of the point of injury is an area looking like a misshapen zooecium. However, if the attack is made at one place by several small *Corambe,* or the animal remains a long time in the same place and grows considerably, the injury will be correspondingly greater and perhaps permanent. So prevalent are these attacks that it is rare to find under natural conditions an uninjured colony of, say, 10 mm. in diameter." But few traces of diatoms in the alimentary canal, such as Fischer cites, have been found, though they may be present at certain times of the year. Since the hard parts of the bryozoan do not appear to be eaten, it is not surprising to find no trace of them. The animals are sluggish, except when removed from the surface of the host, when they tend to move around rather actively, until they find their usual surroundings again.

External characters: The general color of the dorsal aspect is a clear, translucent gray, veined and dotted with pale yellow or greenish yellow. The central area of the notæum is thickly set with light garnet-red or terra cotta spots, located deep below the surface. The edges of these flecks usually appear deeper in color than the center, at times becoming greenish or black. Intermingled with these spots are flecks of black and baryta-yellow. Toward the margins the baryta-yellow flecks tend to unite into irregular, radial lines, sometimes in pairs, but usually single. Occasionally a series of irregular, longitudinal lines is developed in the median region. The foot is of clear gray, with a narrow, white, marginal line. Its central and posterior region is occupied by a vaguely defined, darker, greenish area, due to the denser viscera showing through the integument. The branchial plumes are transparent gray with a few scattered flecks of garnet upon them. The young forms have no color pattern, but are a pale, almost transparent gray, with the black eye spots clearly showing.

Notæum: The notæum is very thick, slightly less so in the median area than at the sides. In general, its surface is smooth, or slightly roughened, the color markings exaggerating the impression of a tuberculate surface. The low, cuboidal epithelium of the dorsal surface secretes a thick, cuticular layer, which shows distinct stratification in sections. Its thickness varies markedly in different specimens, sometimes being merely a moderate layer (Fig. 4), in others presenting a thickness six to 10 times the height of the cells producing it (Fig. 3). Without doubt the dorsal cuticle of the notæum is periodically shed as a continuous sheet, and renewed, lines of cleavage parallel to the surface being shown in sections, and the detached, entire cuticle is frequently found in the aquariums, while animals still covered with the partially free cuticle are not uncommon. This phenomenon was also noted by Fischer (1891) in *C. testudinaria,* and appears to be without a parallel in other nudibranchs. Imbedded in this cuticular layer are abundant, conical, spine-like structures, in sections staining more strongly than the surrounding cuticle, and more resistant than it. These are the products of special, large, epithelial cells, occurring at intervals in the epidermis, each one of which secretes above it this cuticular modification. In those cases in which the general cuticle is but thin, these spines project freely above the surface, giving it a minutely roughened texture. Where the cuticle has become much thickened, two or three such spines may be seen in sections, one above the other, the lowermost and smallest resting upon the cell which has produced the series, the superimposed ones elevated above it in the order of their formation, and being cast off by the successive moultings of the cuticle, probably associated with growth periods (Fig. 3). A similar structure has been described by MacFarland (1918) for the palatal spines of a Tectibranch, *Dolabella agassizii* MacF. Toward the margin of the notæum these spines are increased in number, and are often closely crowded, while toward the central areas they are less numerous. Scattered among the cuticle-secreting cells are numerous, giant, mucous cells, the pear-shaped cell-body lying below the general epithelium and prolonged as a duct to its surface, from whence it is continued by a slender canal through the thickness of the cuticle.

The wide notæum margin conceals the head entirely. The angles of the latter are prolonged into short, blunt tentacles somewhat triangular in form. The tips of these tentacles may project beyond the notæum margin when the animal is crawling freely, or may be entirely concealed. The same is true of the tips of the gills at the posterior end.

The rhinophores (Fig. 2) are retractile within low, entire sheaths. The axis of the rhinophore is prolonged into a tapering, blunt tip, and bears two pairs of revolute lamellæ. The outer pair of these (*o*) are united into a sheath-like structure, fused in front lengthwise to the greater portion of the stalk, being free only at the upper one-fourth, there encircling the rhinophore in a collar-like form, the margins curving downward around to the posterior face of the stalk, where they terminate a short distance apart. Within this outer investment the second pair of laminæ (*i*) are inclosed. Each arises from the side of the stalk as a thin plate curving backward, united below with the stalk, and their free, posterior margins terminate above those of the outer pair. In the median line, behind, a single, thin, keel-like ridge extends from near the tip of the rhinophore downward, dying away as the stalk of the latter enlarges toward the bottom of the inner, lateral pair of lamellæ. Since these laminæ are attached to the stalk of the rhinophore, are retracted with it, and bear the same relation to it as the plates of the common, perfoliate clavus of the nudibranch rhinophore, they cannot be termed sheaths, that designation being restricted to the elevated margin of the opening of the notæum, into which the rhinophore is withdrawn. This misuse of terms is committed by Bergh (1871, 1892), and also by Fischer (1891).

Branchiæ: The branchiæ (Fig. 5) are located at the posterior end of the body, attached to the under surface of the notæum above the foot, and arranged symmetrically in a single, horizontal row on either side of the anus, and usually united above it by a single plume. They vary in number on each side up to 12 or 14 in the largest individuals. They are simply pinnate plumes consisting of a flattened, tapering axis, upon either side of which is borne a series of oppositely arranged, respiratory lamellæ, varying in number up to 20. In the smallest, most anterior gills the plates are reduced to one or two, or the whole organ may be represented by the rhachis alone as a slight projection from the body wall. The branchiæ increase progressively in length and in the number of lamellæ toward the posterior end of the animal, the largest being usually the pair adjacent to the anal opening, or the second or third pair from it. The series extends forward not more than one-third of the length of the foot. In a specimen of 6.8 mm. body length the length of the plumes ranged from 0.25 mm. for the shortest to 0.95 mm. for the longest, which were the third pair from the posterior end of the series. In these last the lamellæ reached 20 in number. In *Corambe testudinaria,* as described by Fischer, the number of branchiæ is fewer, four to seven, and the number of lamellæ on each side of the rhachis is much fewer (up to four). The lamellæ are also arranged alternately upon the sides of the stalk, whereas in the present species they are opposite. The most anterior gill is stated by Fischer to be located nearly midway of the body length, which is decidedly farther forward than in our species, despite the greater number of plumes present in the latter. The tips of the posterior gills are visible at times beyond the notæum margin, but ordinarily they are concealed, save below the median notch. A kind of respiratory movement has been noted in animals under observation in aquariums. The posterior end of the mantle is raised well away from the substratum and the gills protruded to their fullest extent at irregular intervals. This reaction occurs more frequently when the water has been standing for some time. Movement of minute particles suspended in the water indicate a strong current laterally toward the sides of the body, beneath the no-

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tæum margin, and backward past the gills and through the elevated, median, dorsal notæum notch.

Bergh (1871) describes and figures in his Figs. 23 and 24 of Plate XI and Fig. 1 of Plate XII for *Corambe sargassicola* Bgh., an entirely different type of gill, made up on either side of a group of thin, horizontal lamellæ, 13 to 15 in number, obscurely arranged in an upper, wider and longer, and a lower, narrower and shorter set. No intimation of a pinnate arrangement is given, though later (1892, p. 165-166) he indicates this as a generic character, evidently following the more reliable observations of Fischer.

Just above the line of insertion of the branchiæ is a series of simple, alveolar glands, most of which alternate in position with the insertion of the gill stalks (Fig. 5, *g*). They are spherical in form, and are composed of large, clear, pyramidal cells extending from the basement membrane almost to the opening of the gland, leaving but a small lumen (Fig. 6). Each gland opens to the external surface through a very short and narrow duct near the base of the gill. No trace of the single, branched, median gland, described and illustrated by Fischer, is here present, though it is probably represented by this series of simple glands coextensive with the branchial insertion. When floating at the surface, the animal produces a very abundant, mucous secretion. Structurally, these glands appear to be of a mucous nature, but whether they contribute largely to this film of secretion or not has not been determined. As a rule such secretions are produced by the pedal glands to aid in adhesion or floating.

Alimentary tract. The mouth is revealed in ventral view by the triangular notch in the anterior margin of the foot. The external lips are rather thick and glandular, and lead into a short, oral tube, the cuticle of which is but slightly thickened. The inner lips, surrounding the opening into the cavity of the pharyngeal bulb, are but slightly developed and show a moderate thickening of the cuticle on the sides, and ventrally extending into the bulb. No clearly differentiated, lateral plates, such as are described by Bergh (1892), can be made out. The pharyngeal bulb (Pl. 3, fig. 11) bears a thick-walled, muscular crop (*c*) above, such as is characteristic for the Goniodoridæ. The posterior part of the radula sack forms a prominent median ridge (*r. s.*) upon the hinder face of the bulb. The radula is very small, attaining a length of but 0.25 mm. in a large specimen. Its dorsal surface is deeply grooved longitudinally in the median line. There are from 38 to 40 transverse rows of teeth present in large specimens. The half rows are not exactly opposite each other in the two sides of the radula, which, together with the minute size of the elements, renders the count of the rows difficult and often uncertain. The dental formula for the older part of the radula is 4+1+0+1+4, in the younger portion, in the sheath, the laterals are frequently increased by one, giving a formula of 5+1+0+1+5. The rhachis is very narrow and destitute of median teeth, the innermost lateral (Figs. 15, 16) is relatively large and quite different from the remaining ones. In form it somewhat resembles that of *Acanthodoris*. From a roughly quadrilateral, compressed, basal portion a strong, somewhat curved hook arises at the anterior, upper angle. The hook is nearly equal to the base in height, is directed obliquely inward and backward, and is terminated by a blunt point. On the lower half of its inner margin is borne a series of four to seven pointed denticles. From the upper half of the inner face of the base a narrow, recurved, wing-like extension (Fig. 16, *w*) projects downward, curving beneath the base as a ridge across to the opposite side. The posterior margin of the base is thickened, and its outer, upper angle (Fig. 15, *a*) forms a low, compressed, triangular hook, pointed backward. From the oldest, most anterior teeth of the radula backward, there is a steady increase in the dimensions of the teeth, but the relative proportions remain about the same. In an average first lateral tooth the total height from insertion line on the basement membrane to the tip of the hook is 0.09 mm., while the height of the hook itself is 0.04 mm., and the greatest length of the base is 0.05 mm. The outer, lateral teeth, four to five in number (Figs. 12, 13, 14), consist of a rounded base, which is prolonged obliquely upward and backward as a simple, tapering, pointed hook, triangular in outline and rounded above, and below supported by a lamina, which dies away before the tip is reached. The outer laterals tend progressively to be more and more compressed, and the fifth, when present, is usually reduced to a small, flattened plate. In length in an average row the second lateral measures 0.03 mm., the third 0.026 mm., the fourth 0.025 mm., the fifth 0.022 mm., and the outermost 0.012 mm.

The single pair of salivary glands form a compactly rounded mass lying upon the upper face of the pharyngeal bulb, at either side of the beginning of the œsophagus. They are alveolar in type, but slightly branched, and are composed of large cells, which leave but a small, irregular lumen, leading by a rather wide duct into the cavity of the bulb, lateral to the radula. Their staining character and general cytological structure indicate that the secretion is predominatingly mucous in nature.

The strikingly thin-walled œsophagus, lined with ciliated, columnar epithelium throughout its extent, leads directly downward and backward to the anterior end of the stomach. Into it open at once the very wide, biliary passages of the liver. These are five in number, an anterior and a posterior lateral pair, and a single, posterior, median one, which bifurcates into the posterior lobe of the liver. This organ presents a ventral, median, undivided portion from which project five lobes, an anterior and posterior one on either side, and a single, median, posterior one, which last shows a median, posterior notch externally, corresponding with the subdivision of its inner cavity. The right, anterior, paired lobe is quite small, its space being largely occupied by the anterior, genital complex, against the posterior face of which it extends as a narrow strip. Its fellow on the opposite side is large, nearly equalling the whole of the anterior genital mass in size. The posterior, lateral pair is likewise large and well developed. The walls of the liver are composed of a single layer of cuboidal, granular cells lining the roomy lumen of the gland and the numerous short and wide sacculations opening into it. This cavity is strikingly large, with relatively simple ramifications, and communicates widely with the cavity of the stomach, so freely in fact, that it is difficult to fix the boundaries of the anterior portion of the stomach, its contents passing readily into the cavity of the liver, where the main, digestive changes probably take place. What gives solidity and compactness of appearance externally to the organ, in fact, is the thick layer of the ovotestis, which invests the dorsal and lateral faces of the liver completely. Divested of this covering, the liver would present five, slightly ramified, broad and irregular tubes, resembling more the branched arrangement of the Aeolids rather than the compact liver of the Dorids. The median, dorsal surface of the ovotestis-liver mass is occupied by a wide depression passing its full length, in which are contained the stomach and intestine, the heart and pericardium, and the kidney. No "biliary cyst" can be distinguished.

Between the adjacent liver lobes well developed, muscular septa unite the notæum and the foot and extend from the lateral body wall inward as far as the cleft between the lobes permits. Similar incomplete partitions are also found extending obliquely inward between the sides of the pharyngeal bulb and the liver on the left, and the anterior, genital complex on the right.

Dorsally, the stomach is clearly marked off, appearing as a retort-shaped sack, broadest at the left of the median line and narrowing into the rather slender intestine as it curves to the right, thence passing straight backward to the anus in the posterior, median line. Its wall is made up of cuboidal, ciliated cells, surrounded by a layer of circular muscle fibres and connective tissue. The epithelium of the intestine is the same, but its layer of muscle is very thin, and at times apparently absent. At the anus, however, the circular muscle is thickened into a well-developed sphincter, as noted by Fischer (1891).

The anal opening is situated in the median line of the body at the posterior end, immediately below the notch in the notæum. Close by, at the right and slightly above it, is the minute opening of the renal organ. Neither structure is conspicuous externally.

Nervous System: Close behind the salivary glands is the central, nervous system. The ellipsoidal, cerebral ganglia (Pls. 2, 3, figs. 8, 10, *c*), the largest of the group, are in contact along their inner faces, but are not fused, being connected by a distinct, broad, cerebral commissure above the œsophagus. Below the latter they are also connected by a delicate, sub-œsophageal commissure, recognizable in sections. From the anterior portion of the cerebral ganglia are given off the nerves to the rhinophores and the eyes, each bearing an elliptical ganglion close to its origin (Figs. 8, 10, *c.1, c.2*), and three other pairs (Figs. 8, 10, *c.3, c.4, c.5*) to the bùccal tentacles, and the mouth and head region. From the fifth of these, as a basal branch, or very close to its origin, is given off the cerebro-buccal connective, which passes beneath the œsophagus to the buccal ganglion (Fig. 10 *c.b.c, b*). The optic nerves are rather short, the eyes small and deeply buried below the integument, behind and medial to the rhinophores. The nearly spherical statocysts lie close in the outer angle between the cerebral and pedal ganglia. They measure ca. 0.03 mm. in diameter, and contain many ellipsoidal statoliths, 0.002 mm. by 0.003 mm. in diameter. Lateral to the œsophagus are the spherical, pedal ganglia (Figs. 8, 9, 10, *p*), second in size to the cerebral pair, and joined to them by short, cerebro-pedal connectives (Fig. 10, *c. p. c*). The pedal ganglia are united below the œsophagus by the usual, well developed, pedal commissure (Fig. 9, *p. c*), and also by a distinct, more slender, parapedal commissure (Fig. 9, *pp. c*) separated some distance from the main, pedal one. These commissures are very much shorter than those figured by Fischer (1891) for *C. testudinaria*. From the pedal ganglia are given off the stout, anterior, median, and posterior pedal nerves, distributed to the corresponding regions of the foot, the latter two either arising separately, or from a common stalk, which soon bifurcates.

Immediately behind the cerebral ganglia and slightly below them are the distinct pleural ganglia (Figs. 8, 9, 10), united with the cerebral and pedal ganglia by the cerebro-pleural and pleuro-pedal connectives respectively (Fig. 10, *c-pl. c, pl.-p. c*). As a rule in the Nudibranchiata the pleural ganglia are fused more or less completely with the cerebral pair, there being varying degrees to which this fusion is indicated externally. In *Corambe testudinaria* Fischer (1891), figures (l. c. Figs. 20, 21, 22) the cerebral and pleural (pleuro-palleal) ganglia as fused in a common, supra-œsophageal complex, as indicated by an external, transverse groove, and by the cerebro-pedal and pleuro-pedal connectives, arising from the fused, ganglionic mass. In the present species, however, the separation of the pleural from the cerebral ganglia is equally clear and unmistakable. This difference in such fundamental structures in two allied species of the same genus is very remarkable, and appears without a parallel, so far as we are aware, in the Nudibranch literature.

Uniting the pleural ganglia below the œsophagus is the visceral loop (Figs. 8, 9, *v. c*), bearing a ganglionic enlargement a short distance from its right end, which gives rise to a single nerve, dividing into a stronger, right and a more slender, left branch. The left one bears two small ganglia at a short interval apart, from each of which fine nerves arise and pass backward to the viscera. The right nerve breaks up into a number of fine rami, which apparently pass mainly to the reproductive organs. From the pleural ganglia themselves anterior and posterior nerves arise. On the left side the posterior, pleural nerve is usually single, on the right it arises as either two, separate roots (Figs. 8, 10, *pl. 2, pl. 2a, pl. 2b*), or as a single one (Fig. 9). The one on the right side sends an anastomosing branch at once to the anterior, pleural nerve (Figs. 8, 9, *pl. 1*). The anterior pleural nerve arises on the left side from the cerebro-pleural connective (Fig. 10, *pl 1*), close to its union with the pleural ganglion usually, but receiving fibres from both cerebral and pleural ganglia. In some cases, as in Fig. 9, it may be given off from the ganglion directly. It divides at once into two branches which pass to the dorsum.

Excretory System: The kidney consists of a roomy, thin-walled sack, mainly lying below the heart, and above the ovo-testis and liver. The semi-diagrammatic Fig. 17 of Plate 3 represents the reno-pericardial system in outline, in its relation to the posterior portion of the body, as seen in longitudinal section. In its maximum width it extends across the full diameter of the visceral cavity. Anteriorly it narrows abruptly to about one-fourth of its greatest width, and is prolonged forward, slightly to the left of the median line, to a point approximately opposite the middle of the anterior, genital complex, where it terminates in an irregular, blunt tip. Below, in the region of its greatest width, it sends a keel-like prolongation downward (Fig. 17, *v*) into the dorsal, median furrow of the ovo-testis. The surface of its wall is simple and smooth, save for a small number of low, lateral and dorsal folds, which appear in front of the cardiac region. Its lining epithelium is made up of clear, cuboidal to columnar cells with basal nuclei. The renal syrinx (Fig. 17, *s*) is relatively large and is cylindrical in form. It opens through the pericardial floor at the right of the median plane, below the ventricle of the heart, is directed downward, backward, and to the right, narrowing into the slender, reno-pericardial tube (Fig. 17, *r.p. t*), which recurves in a loop at the right of the median, ventral lobe of the kidney to pass forward in contact with its right ventral wall, opening into its anterior prolongation well in front of the pericardium, and a short distance behind the pharyngeal bulb. The syrinx is lined with clear, cuboidal cells bearing very long cilia. Posteriorly, the wider portion of the kidney-sack narrows abruptly into a short, narrow, renal tube which opens externally (Fig. 17, *r*) above, and slightly to the right of the anus (Fig. 17, *a*; Fig. 5). The kidney differs from that of *C. testudinaria* as described by Fischer (1891), chiefly in its somewhat different outline, the local folds in the renal epithelium, and in the ventro-anterior, rather than anterior opening of the reno-pericardial tube into the renal sack.

Reproductive System: The ovotestis, in a mature individual, forms a thick covering completely concealing the dorsal and lateral surfaces of the liver, its main lobes corresponding in number and outline to those of the latter organ. From each lobe a branch of the hermaphroditic duct arises by the union of several tributaries from the follicles of the ovotestis. These unite dorsally into the main duct near the median line, which passes forward to the inner face of the anterior, genital complex, made up of the nidamental or mucus, and albumen glands and the related ducts. This complex occupies the right, anterior quadrant of the body cavity. It is trapeziform in shape, as seen from above; its outer, longer face is convex, conforming to the contour of the body wall; its inner face, one-half as long, is flattened against the left, anterior lobe of the liver-ovotestis below; its posterior face is directed obliquely outward and backward in close contact with the almost rudimentary right, anterior lobe of the liver-ovotestis; while the anterior face slopes obliquely forward and outward in contact with the vaginal duct and penis. Upon the anterior, inner face the slender, hermaphroditic duct dilates into the ellipsoidal hermaphroditic ampulla, from the upper extremity of which a short duct continues into the cavity of the albumen gland, giving off at right angles the vas deferens. The latter has a thick, glandular wall, loops downward around the hermaphroditic ampulla upon the median face of the complex to its dorsal border, thence describes a free loop obliquely backward in front of the stomach, returning in a series of close turns, caused by the varying tension of the retractor muscle of the penis, which is inserted upon it immediately at the right of the central nervous system. The penis extends obliquely forward close to the right of the pharyngeal bulb in front of and parallel with the vaginal duct and the duct of the nidamental-albumen gland complex, to its external opening far forward on the right side of the body near the head. In its retracted condition this organ is made up of an eversible preputium, a rather thin-walled, muscular sack, at the bottom of which arises the glans penis. In its everted position, as shown in Fig. 7, *p* of Plate 2, it extends from the external opening as a cylindrical structure, terminated by the bluntly conical glans (*g*), and usually showing a few slight, circular rugæ, while near the base of the glans proper is frequently found a more prominent ring-like thickening. The organ is entirely unarmed.

Immediately behind the external opening of the penis sack is the vaginal orifice, and slightly below it is that of the duct from the accessory glands. The vagina (Fig. 7, *v*) passes inward along the upper and medial border of the genital mass, curves outward and describes a loop upon its upper, posterior face, recurving to the median plane, where it opens into the thin-walled, ovoid spermatotheca (Fig 7, *s*). Near its entrance the much more slender, vaginal duct (Fig. 7, *vag.* d) emerges, passes forward in a short, straight course, receives the duct of the quite small, ovoid spermatocyst (Fig. 7 *s. c*), and passes into the interior of the accessory gland complex, opening into the irregular lumen of the albumen gland close to the entrance of the oviduct. The cavity of the nidamental gland is relatively roomy and simple, is connected by a short, ciliated passage with the albumen gland lumen, and opens externally by a wide, short duct, which parallels the penis and vagina, its separate opening being slightly below them. Fischer (1891) was unable to find a spermatocyst in *C. testu-*

dinaria, but, with this exception, our results as to the general organization of the reproductive system are in agreement. The nidosomes are common upon the *Membranipora* colonies and the adjacent surface of the kelp. Each consists of a narrow, somewhat flattened band coiled in a close spiral of from one to three turns, attached by one margin. Each nidosome contains from 500 to 1500 capsules, and each capsule contains but a single egg. The larger the animal the more capsules there are in the nidosome. It is not known whether one animal can lay more than one nidosome at a time or in a season.

Blood gland: Immediately behind the pharyngeal bulb, in contact with the central, nervous system, is located the blood gland, resting on the œsophagus. It is discoidal, nearly circular in outline, with quite fine lobulations.

The anatomy of the heart and the vascular system does not appear to differ materially from that described for *Corambe testudinaria* Fischer by that author, and hence need not be repeated here.

The following comparative tabulation indicates the most significant differences between our species and that of Fischer:

Corambe testudinaria Fischer	**Corambe pacifica** MacF. & O'D.
Maximum size 4 mm. long, 3.5 mm. wide.	Maximum size 13.0 mm. long, 10.0 mm. wide.
Branchiæ 4 to 7 on each side, the most anterior situated midway of body length in large specimen.	Branchiæ up to 14 on each side, the most anterior situated at 1/3 of body length from posterior end.
Branchial lamellæ few, up to 4 in number, alternate on shaft of gill.	Branchial lamellæ up to 20 in number, opposite on shaft of gill.
A single, posterior, branched, median gland opening externally above renal pore.	A series of simple, alveolar glands at bases of gill plumes.
Radula 30-35 $\times$ $(4 + 1 + 0 + 1 + 4)$	Radula 35-40 $\times$ $(4-5 + 1 + 0 + 1 + 4-5)$
A median, cuticular plate in front of radula.	Absent. General cuticular thickening only.
Liver tri-lobed.	Liver five-lobed.
Cerebral and pleural ganglia fused.	Cerebral and pleural ganglia separate.
No spermatocyst.	Spermatocyst present.

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Plate 1

Fig. 1. Dorsal view of large, living *Corambe pacifica* MacF. & O'D. ×5.

Fig. 2. Rhinophore from behind. *o*, outer lamina, *i*, inner lamina. ×35.

Fig. 3. Transverse section of epidermis and cuticle of notæum. The cuboidal epithelium below secretes a thick cuticle, which is periodically shed, becoming split off by a cleft parallel to the epithelial layer. Large, special cells of the epithelium produce blunt, conical spines in succession, three generations of such spines being seen in the figure. ×800.

Fig. 4. Transverse section of epithelium of notæum from near the margin. The cuticle is much thinner than in Fig. 3, it having been shed more recently. Three cuticular spines and a large, unicellular gland are shown. ×800.

Fig. 5. Posterior end of animal, as seen from the ventral aspect. The foot has been removed by a cut through the body wall above it, along the curved lines uniting *a*—*a*. The branchial plumes are seen in place, the ventral surface of the notæum margin, with the median, posterior notch, lying behind them. A single, median plume, just above the anal opening, and ten lateral ones on either side are present. At the bases of the branchiæ the series of alveolar glands, *g*, shows through the integument. The intestine and renal sack open externally near the median line. ×28.

Fig. 6. Section of alveolar gland, situated at the base of the branchial plumes. ×590.

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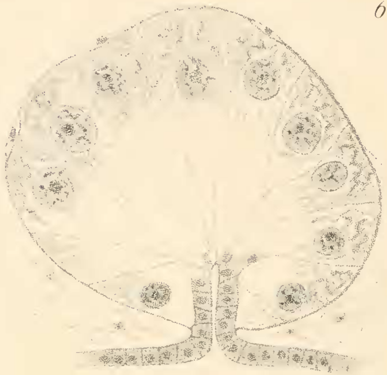

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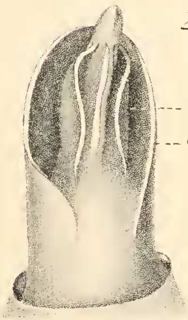

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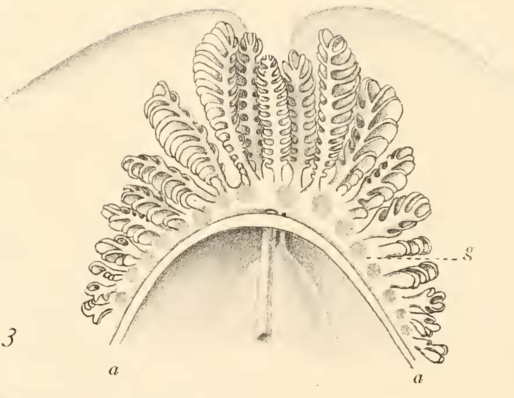

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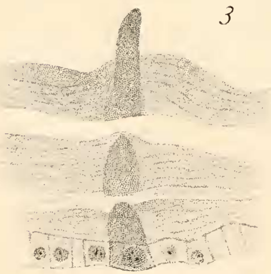

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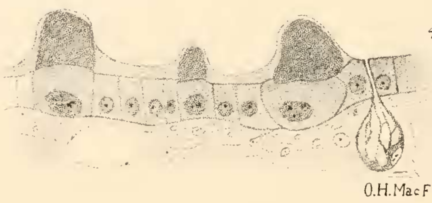

PLATE 2

Fig. 7. Portion of Reproductive System. *v. d*, Distal part of vas deferens, extending into the everted preputium, through the wall of which its terminal portion is faintly seen. The everted preputium, tipped by the conical glans, *g*, forms the penis, *p*. Close to the right of the base of the penis is the external opening of the vagina, *v*, which leads inward to the spermatotheca, *s*; the short and narrow vaginal duct, *vag. d*, continues on into the accessory gland complex, and receives the duct of the spermatocyst, *s. c*, close to its entrance. ×16.

Fig. 8. Central Nervous System in dorsal view. *c*, Cerebral ganglia; *c. 1*, rhinophore ganglion and nerve; *c. 2*, optic ganglion, optic nerve, and eye; *c. 3*, *c. 4*, *c. 5*, nerves to buccal tentacles and mouth region; *p*, pedal ganglia; *pl*, pleural ganglia, distinctly separate from the cerebral pair, to which they are joined by the cerebro-pleural connective, *c-pl. c*; *pl. 1*, first, pleural nerve, *pl. 2*, second, pleural nerve of left side; *pl. 2a*, *pl. 2b*, rami of second, pleural nerve of right side; *v. c.*, visceral commissure, uniting the pleural ganglia below the œsophagus. ×122.

Fig. 9. Postero-ventral view of Central Nervous System, the severed œsophagus, *o*, being left in place. *p. c*, pedal commissure, *pp. c*, parapedal commissure, the other abbreviations as in Fig. 8. In this dissection the first, pleural nerve of the left side, *pl. 1*, arises directly from the ganglion, and not from the cerebro-pleural connective, as in Fig. 8, while on the right side the second, pleural nerve arises from a single root, dividing at once into *pl. 2a*, and *pl. 2b*, with anastomosing branches to *pl. 1*, as in Fig. 8. ×122.

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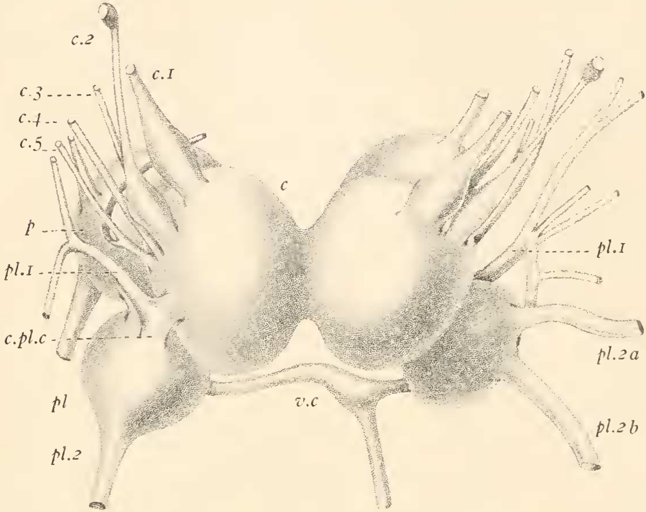
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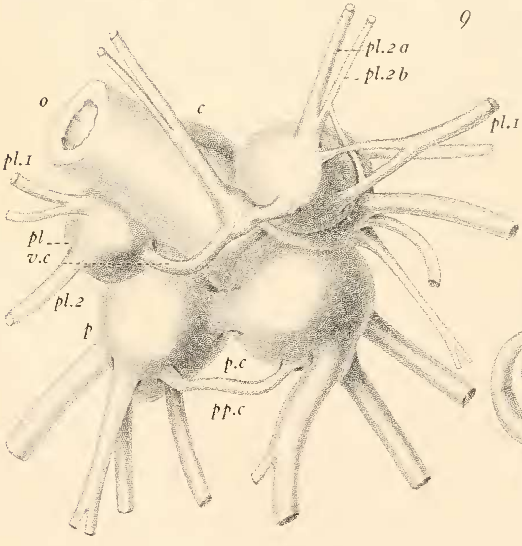
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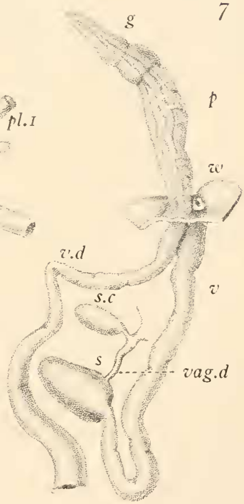
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